

Radial Extension Study of the 64-m-Diameter Antenna

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An increase in the paraboloidal RF capturing area of the 64-m-diameter antenna with minimal increase of the surface distortion may be attractive from the operations standpoint. A study of the problems involved in increasing from a 64-m-diameter to a 68-m-diameter and the resulting distortion increase due to gravity loadings is described. It is planned to document the effects of calculated wind and thermal loadings in future reporting.

I. Introduction

One of the major factors that determines the RF performance of the 64-m-diameter antenna is the size of its paraboloidal reflecting surface. An increase of its diameter over the present 64-m-diameter size with minor deterioration of the surface distortions from gravity, wind, and thermal loadings may result in a more effective ground antenna. To evaluate this possibility, a study was made of the structural modifications required to extend the diameter by 4 m (64- to 68-m-diameter total) and compute distortions of the reflective surface resulting from the environmental loadings.

In this article, a description of the extension of the hyperboloid's diameter is outlined. Also, the plan for adding the extension to the reflector structure is described along with the computed distortion rms due to gravity loadings only. In future reporting, the rms distortions from wind and thermal loadings will be described.

II. Extension Geometry

Figure 1 describes the extension geometry required on the paraboloid and Fig. 2 shows the extension required on the hyperboloid.

On the hyperboloid, there is presently a flat of about 0.3 m (12 in.) attached to its periphery. The extension would require a hyperboloid surface varying from 0.207-m (8.165-in.) to 0.253-m (9.973-in.) widths with again a flat or cone surface of 0.3 m (12 in.) attached.

One method of extending the surface would be to remove the present flat and attach the required hyperboloid surface and the flat. Some connections to the backup structure will be necessary to insure stiffness of the new surfaces.

This increase in the hyperboloid diameter decreases the clearances to the quadripod structure to a minimum, if

allowance for focusing and a full 10-cm (4-in.) lateral Y adjustments are necessary in the future.

III. Reflector Structure Extension

The reflector structure of the 64-m-diameter antenna is basically a structural arrangement of radial trusses connected by hoop trusses as shown in Figs. 3 and 4. There are other trusses interconnected to it to serve as supports for the quadripod, the elevation wheel structure, and the elevation bearing, which are not affected by the modification under discussion.

The two functions of the hoop trusses near the outer edge are (1) to provide supports for the surface panels between the main radial rib trusses at the intermediate rib positions; the air and gravity loadings at node B in Fig. 3 are transferred to the radial ribs at nodes A and H; and (2) to provide hoop restraints as the radial rib nodes increase or decrease in circumferential length from the radial component of the deflections caused by environmental loads. These hoop forces provide distortion restraints.

One practical structural arrangement for a radial extension is shown by dotted lines in Fig. 4. An outside hoop for circumferential stiffness is provided by a typical rod DHM and the stiffness for the localized environmental normal loadings at node H will be transferred to the radial rib by the truss LHP typically.

IV. Computer Analysis Description and Analysis

The extension trusses were added to the $\frac{1}{2}$ model of the reflector structure that includes all the structural members of the tipping assembly about the elevation axis with the exception of the intermediate rib. Since the intermediate rib is not a truss, it was replaced by an equivalent weight to reduce the size of the model. Therefore, the extension was modeled only with the addition of a truss addition (LMP of Fig. 4) to all of the radial ribs and hoops DM between each extension. The equivalent weights of the additional trusses were then added at nodes L, M, and P.

The gravity "off" to "on" loadings for the zenith and horizon looks were applied and the resulting displace-

ments of the reflector nodes where the surface panels are supported from the NASTRAN computer analysis were best fitted and the residuals contour plotted by the rms program (Ref. 1).

V. Results and Conclusions

An unexpected result occurred for the zenith look gravity loading case where there was an improvement in rms value from 1.05 mm to 0.98 mm. The explanation is that the additional peripheral loadings from the extension trusses are in the direction resulting in a better fit to the best fit paraboloid. This is shown in the contour map of Fig. 5 of the best fit residuals of the zenith or symmetric loading. Inspection shows that the major part of the periphery of the reflector where the extensions are added are still high. It will be interesting to pursue further this weight addition method of improving the overall distortion figure.

The results of the horizon look or antisymmetric gravity loading show expected discontinuities of the contour lines near the periphery of the reflector caused by the deflections of the added nodes (Fig. 6). However, the magnitude of the added deflections at this moment appears to be larger than that consistent with the added diameter. Additional study of the modeling of the extension will be made to check for this case of the loading vectors out of the plane of main rib trusses.

The computed distortions based on the existing modeling are documented and compared to the existing 64-m-diameter computed rms distortions in Table 1.

For the extreme elevation angle cases where the reflective surface panels are set at 45° , the rms distortions stated are the changes in the reflector structure distortions from zero rms at 45° due to gravity loadings only. Therefore, the panel manufacturing errors as well as the equivalent rms loss due to feed mismatch with the focal points as well as the distortion due to wind and thermal loads must be added to form the complete distortion figure.

Also, an area weighting function based on the RF illumination amplitude was used as per Fig. 7 in computing the rms figure.

Reference

1. Katow, M. S. and Schmele, L. W., "Antenna Structures: Evaluation Techniques of Reflector Distortions" in *Supporting Research and Advanced Development*, Space Programs Summary 37-40, Vol. IV, pp. 176-184. Jet Propulsion Laboratory, Pasadena, Calif., Aug. 31, 1966.

Table 1. Computed distortion rms—reflector structure only

	Elevation position	Loading case	Best fit—rms			
			64-m- diameter		68-m- diameter	
			mm	(in.)	mm	(in.)
1	Zenith look	Gravity off/on	1.04	(0.041)	0.99	(0.039)
2	Horizon look	Gravity off/on	2.06	(0.081)	2.26	(0.089)
3	Zenith look	Panels set at 45° elevation	1.55	(0.061)	1.65	(0.065)
4	Horizon look	Panels set at 45° elevation	1.02	(0.040)	1.04	(0.041)

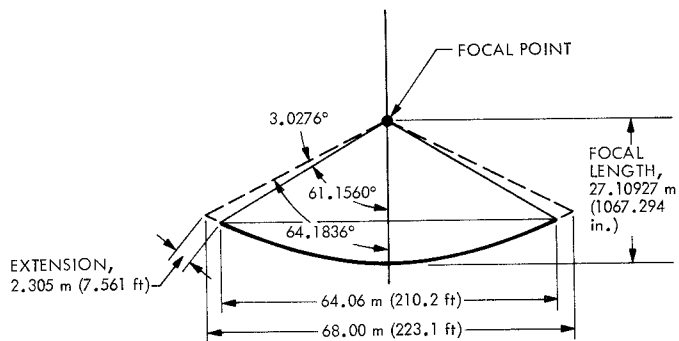


Fig. 1. Paraboloid geometry

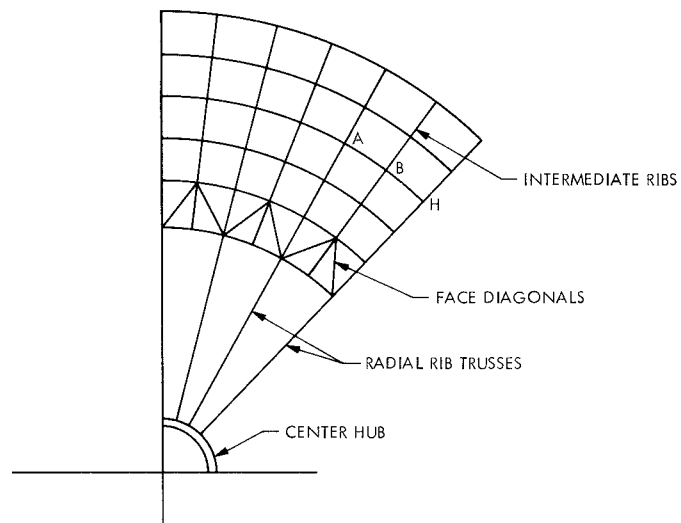


Fig. 3. Reflector structure, partial plan view

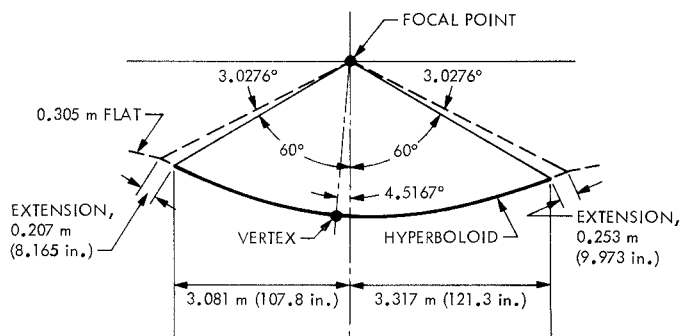


Fig. 2. Hyperboloid geometry

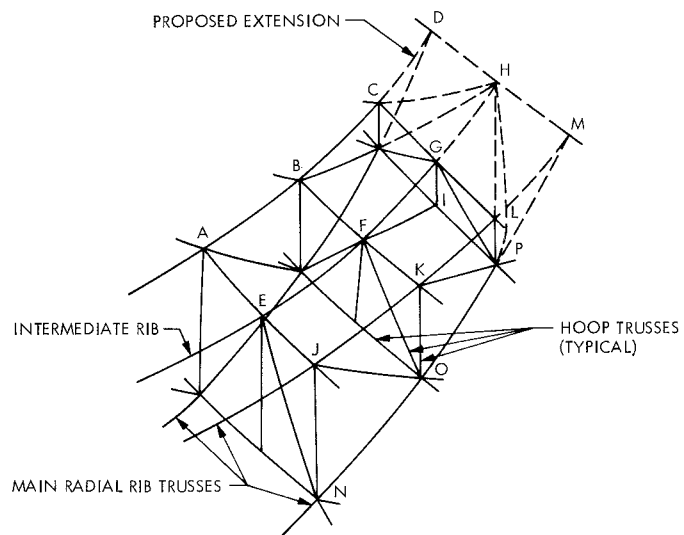


Fig. 4. Reflector structure between two radial rib trusses

